PBEEEP
State Government

Public Buildings Enhanced Energy Efficiency Program

Final Report
Investigation Results For
Lake Superior College

Date: 6/12/2012

Lake Superior College

Table of Contents

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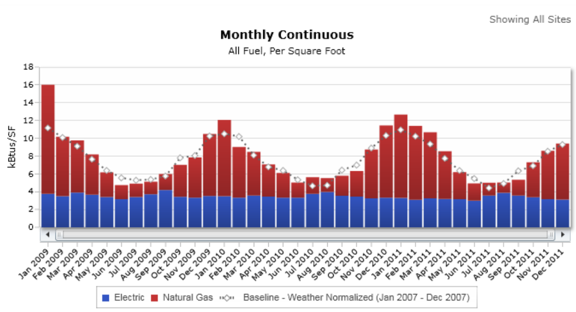
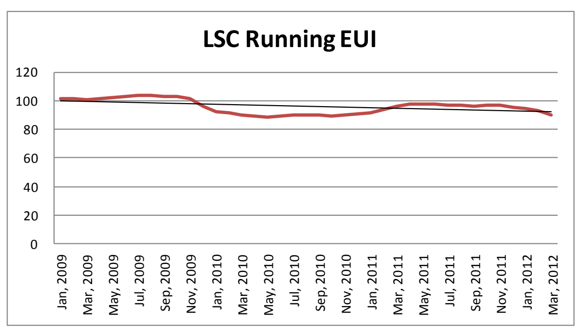
Lake Superior College Energy Investigation Overview

The goal of a PBEEEP Energy Investigation is to identify energy savings opportunities with a payback of fifteen years or less. Particular emphasis is on finding those opportunities that will generate savings with a relatively fast (1 to 5 years) and certain payback. During the investigation phase the provider conducts a rigorous analysis of the building operations. Through observation, targeted functional testing, and analysis of extensive trend and portable logger data, the RCx Provider identifies deficiencies in the operation of the mechanical equipment, lighting, envelope, and related controls. The investigation of Lake Superior College was performed by LHB, Inc. This report is the result of that information.

Payback Information and Energy Savings				
Total project costs (Without Co-funding)			**Project costs with Co-funding**	
Total costs to date including study	$57,857		Total Project Cost	$62,545
Future costs including Implementation , Measurement & Verification	$4,688		Study and Administrative Cost Paid with ARRA Funds	($59,357)
Total Project Cost	$62,545		Utility Co-funding	$0
			Total costs after co-funding	$3,188
Estimated Annual Total Savings ($)	$9,179		Estimated Annual Total Savings ($)	$9,179
Total Project Payback	6.8		Total Project Payback with co-funding	4 months
Electric Energy Savings	**1.3%**	**and**	**Natural Gas Savings**	**4.0%**





Year	Days	SF	Total kBtu	Normalized Baseline kBtu	Change from Baseline kBtu	% Change	Total Energy Cost $	Average Cost Rate $ /kBtu
2009	365	362,241	34,914,646	33,494,371	1,420,275	4%	$477,277.82	$0.01
2010	365	362,241	33,008,193	32,351,081	657,112	2%	$493,214.71	$0.01
2011	365	362,241	34,429,010	32,800,653	1,628,356	5%	$486,907.85	$0.01

Lake Superior College Consumption Report
Total energy use decreased 5% during the period of the investigation

Admin Minnesota
STATE OF MINNESOTA B3 BENCHMARKING

Summary Tables

Lake Superior College	
Location	2101 Trinity Road, Duluth MN 55811
Facility Manager	Gary Adams
Interior Square Footage	362,775
PBEEEP Provider	LHB, Inc.
Annual Energy Cost	$486,908 (2011) Source: B3
Utility Company	Minnesota Power (Electric) Comfort Systems (Natural Gas)
Site Energy Use Index (EUI)	95 kBtu/ft^2 (at start of study) 90 kBtu/ft^2 (at end of study)
Benchmark EUI (from B3)	126 kBtu/ft^2

Building Name	State ID	Square Footage	Year Built
1986 Addition	E26354T0486	42,865	1986
1990 Addition	E26354T0590	31,680	1990
96 Addition	E26354T1196	69,900	1996
Academic & Student Services	E26354T1207	45,735	2007
Art Building	E26354T0775	11,600	1975
Main Bldg A	E26354T0166	119,625	1966

Mechanical Equipment Summary Table (of buildings included in the investigation)

Quantity	Equipment Description
1	Johnson Metasys Automation System
6	Building
321,405	Interior Square Feet
25	Air Handlers
170	VAV Boxes (Estimate, 17 fan powered)
4	Boilers
4	Air cooled chillers
8	Hot water pumps
10	Chilled water pumps (estimated)
2725	Approximate number of points on the BAS
750	Approximate number of points required for trending by PBEEEP Guidelines
20	Data Loggers for Cooling System (does not include loggers for lighting or occupancy sensors)

Implementation Information			
Estimated Annual Total Savings ($)			$9,179
Total Estimated Implementation Cost ($)			$3,188
GHG Avoided in U.S Tons (CO2e)			92
Electric Energy Savings (kWh) 1.3 % Savings 2011 Electric Usage 4,205,510 kWh (from B3)			53,928
Electric Demand Savings (Peak kW)			0
Natural Gas Savings (MMBtu) 4.0 % Savings 2011 Usage 206,798 Therms from B3			8,248
Statistics			
Number of Measures identified			2
Number of Measures with payback < 3 years			1
Screening Start Date	3/29/2011	Screening End Date	5/12/2011
Investigation Start Date	6/27/2011	Investigation End Date	4/11/2012
Final Report	6/12/2012		

Lake Superior College Cost Information		
Phase	**To date**	**Estimated**
Screening	$2,880	
Investigation [Provider]	$47,572	
Investigation [CEE]	$7,405	$500
Implementation		$3,188
Implementation [CEE]		$500
Measurement & Verification	0	$500
Total	$57,857	$4,688

Co-funding Summary	
Study and Administrative Cost	$59,357
Utility Co-Funding - Estimated Total ($)	$
Total Co-funding ($)	$59,357

Facility Overview

The energy investigation identified 2.9% of total energy savings at Lake Superior College with measures that payback in less than 15 years and do not adversely affect occupant comfort. The energy savings opportunities identified at Lake Superior College are based on adjusting the schedule of equipment to match actual building occupancy hours, and adjusting the high limit on several economizers. The total cost of implementing all the measures is $3,188.

Implementing all these measures can save the facility approximately $9,179 a year with a combined payback period of 4 months before rebates based on the implementation cost only (excluding study and administrative costs). These measures will produce 1.3 % electrical savings and 4.0 % natural gas savings. The building is currently performing at 29% below the Minnesota Benchmarking and Beyond database (B3) benchmark; energy usage during the period of the study declined by 5%.

The primary energy intensive systems at Lake Superior College are described here:

Lake Superior College campus consists of 362,775 square feet (sqft) and is compromised of 15 different buildings located in Duluth, MN. There are two locations in Duluth; one area consists of 328,605 sqft which consists of the main campus buildings (5 attached buildings) and four other detached buildings.

Mechanical Equipment

The building group contains 3 boilers which produce hot water for heating: 2 large boilers and one small boiler. There are four hot water loops for distribution. There are a total of 8 hot water pumps distributing hot water from the boilers. The Art building also contains a small boiler which produces steam.

There are a total of four chillers on the campus; two of them are located on the roof of the complex and two smaller chillers called the West End Chiller and East End Chiller which produce chilled water for the campus. The art building is cooled by a DX condensing unit

The main campus building contains a total of 24 AHUs, these units were installed between 1966 and 2007. They are all on the automation system. There are a total of approximately 170 VAV boxes associated with these AHUs, most of the VAVs contain reheats. There are 17 fan powered VAVs also.

The Art building has one AHU which serves the building. It is a constant volume unit with a steam coil for heat. The unit is old and staff states it is a very problematic unit. There are plans to replace this with a condensing boiler dedicated to this building.

Controls and Trending

The building runs on a Johnson Metasys Building Automation System (BAS). The system contains the Application and Data Server (ADS) package which allows trends to be set up and stored on a Sequel Server (SQL). The system did not appear to have the software Export Utility, which can be used to extract the trends from the SQL server. Trends can be extracted directly from the SQL server file, but would require manipulation of data by the provider to get the trends in csv format.

There are approximately 10 chilled water pumps which are not automated and would require data logging to understand their operation.

Lighting

Indoor lighting- Interior lighting consists of mainly T8 32 watt which are controlled by switches.

Outdoor lighting- The outdoor lighting consists of high pressure sodium (HPS) lights. The lights are on timers and controlled on the automation system.

Energy Use Index B3 Benchmark

The site Energy Use Index (EUI) for the building dropped from 95 to 90 kBtu/sqft over the period of the study and is now 29% lower than the B3 Benchmark of 126 kBtu/sqft. The site EUIs for State of Minnesota buildings are 23% lower than their corresponding B3 Benchmarks on average.

Metering

The campus contains a total of nine electrical meters. Three of the meters are associated with the ERTC complex and another one is associated with the cold storage. There are a total of four gas meters and two of them are associated with the ERTC building.

Findings Summary

Site: Lake Superior College

Eco #	Building	Investigation Finding	Total Cost	Savings	Payback	Co-Funding	Payback Co-Funding	GHG
1	Main Bldg A	AHU Operation Schedules Need Optimization	$1,074	$8,576	0.13	$0	0.13	82
2	Main Bldg A	Economizign Operations	$2,114	$603	3.50	$0	3.50	10
		Total for Findings with Payback 3 years or less:	**$1,074**	**$8,576**	**0.13**	**$0**	**0.13**	**82**
		Total for all Findings:	**$3,188**	**$9,179**	**0.35**	**$0**	**0.35**	**92**

PBEEEP was made possible with funding from the U.S. Department of Energy and the MN Department of Commerce.

Lake Superior

Finding Type Number	Finding Type	Relevant Findings	Looked for, Not found	Not relevant
a.1 (1)	Time of Day enabling is excessive	1		
a.2 (2)	Equipment is enabled regardless of need, or such enabling is excessive	1		
a.3 (3)	Lighting is on more hours than necessary.		1	
a.4 (4)	OTHER_Equipment Scheduling/Enabling		1	
b.1 (5)	Economizer Operation – Inadequate Free Cooling (Damper failed in minimum or closed position, economizer setpoints not optimized)	1		
b.2 (6)	Over-Ventilation – Outside air damper failed in an open position. Minimum outside air fraction not set to design specifications or occupancy.		1	
b.3 (7)	OTHER_Economizer/OA Loads		1	
c.1 (8)	Simultaneous Heating and Cooling is present and excessive		1	
c.2 (9)	Sensor/Thermostat needs calibration, relocation/shielding, and/or replacement		1	
c.3 (10)	Controls "hunt" and/or need Loop Tuning or separation of heating/cooling setpoints		1	
c.4 (11)	OTHER_Controls			1
d.1 (12)	Daylighting controls or occupancy sensors need optimization.		1	
d.2 (13)	Zone setpoint setup/setback are not implemented or are sub-optimal.		1	
d.3 (14)	Fan Speed Doesn't Vary Sufficiently		1	
d.4 (15)	Pump Speed Doesn't Vary Sufficiently		1	
d.5 (16)	VAV Box Minimum Flow Setpoint is higher than necessary		1	
d.6 (17)	Other_Controls (Setpoint Changes)			1
e.1 (18)	HW Supply Temperature Reset is not implemented or is sub-optimal		1	
e.2 (19)	CHW Supply Temperature Reset is not implemented or is sub-optimal		1	
e.3 (20)	Supply Air Temperature Reset is not implemented or is sub-optimal		1	
e.4 ( )	Supply Duct Static Pressure Reset is not implemented or is sub-optimal			1
e.5 (21)	Condenser Water Temperature Reset is not implemented or is sub-optimal			1
e.6 (22)	Other_Controls (Reset Schedules)		1	
f.1 (23)	Daylighting Control needs optimization—Spaces are Over-Lit		1	
f.2 (24)	Pump Discharge Throttled		1	
f.3 (25)	Over-Pumping		1	
f.4 (26)	Equipment is oversized for load.		1	
f.5 (27)	OTHER_Equipment Efficiency/Load Reduction		1	
g.1 (28)	VFD Retrofit - Fans			1
g.2 (29)	VFD Retrofit - Pumps			
g.3 (30)	VFD Retrofit - Motors (process)			1
g.4 (31)	OTHER_VFD		1	
h.1 (32)	Retrofit - Motors			1
h.2 (33)	Retrofit - Chillers			1
h.3 (34)	Retrofit - Air Conditioners (Air Handling Units, Packaged Unitary Equipment)			1
h.4 (35)	Retrofit - Boilers			1
h.5 (36)	Retrofit - Packaged Gas fired heating			1
h.6 (37)	Retrofit - Heat Pumps			1
h.7 (38)	Retrofit - Equipment (custom)		1	
h.8 (39)	Retrofit - Pumping distribution method		1	
h.9 (40)	Retrofit - Energy/Heat Recovery			1

h.10 (41)	Retrofit - System (custom)		1	
h.11 (42)	Retrofit - Efficient Lighting			1
h.12 (43)	Retrofit - Building Envelope			1
h.13 (44)	Retrofit - Alternative Energy			1
h.14 (45)	OTHER_Retrofit		1	
i.1 (46)	Differed Maintenance from Recommended/Standard		1	
i.2 (47)	Impurity/Contamination_		1	
i.3 ( )	Leaky/Stuck Damper		1	
i.4 ( )	Leaky/Stuck Valve		1	
i.5 (48)	OTHER_Maintenance		1	
j.1 (49)	OTHER		1	

Findings Glossary: Findings Examples

a.1 (1)	**Time of Day enabling is excessive**
	• HVAC running when building is unoccupied. Equipment schedule doesn't follow building occupancy • Optimum start-stop is not implemented • Controls in hand
a.2 (2)	**Equipment is enabled regardless of need, or such enabling is excessive**
	• Fan runs at 2" static pressure. Lowering pressure to 1.8" does not create comfort problem and the flow is per design. • Supply air temperature and pressure reset: cooling and heating
a.3 (3)	**Lighting is on more hours than necessary**
	• Lighting is on at night when the building is unoccupied • Photocells could be used to control exterior lighting • Lighting controls not calibrated/adjusted properly
a.4 (4)	**OTHER Equipment Scheduling and Enabling**
	• Please contact PBEEEP Project Engineer for approval
b.1 (5)	**Economizer Operation – Inadequate Free Cooling**
	• Economizer is locked out whenever mechanical cooling is enabled (non-integrated economizer) • Economizer linkage is broken • Economizer setpoints could be optimized • Plywood used as the outdoor air control • Damper failed in minimum or closed position
b.2 (6)	**Over-Ventilation**
	• Demand-based ventilation control has been disabled • Outside air damper failed in an open position • Minimum outside air fraction not set to design specifications or occupancy
b.3 (7)	**OTHER Economizer/Outside Air Loads**
	• Please contact PBEEEP Project Engineer for approval
c.1 (8)	**Simultaneous Heating and Cooling is present and excessive**
	• For a given zone, CHW and HW systems are unnecessarily on and running simultaneously • Different setpoints are used for two systems serving a common zone
c.2 (9)	**Sensor / Thermostat needs calibration, relocation / shielding, and/or replacement**
	• OAT temperature is reading 5 degrees high, resulting in loss of useful economizer operation • Zone sensors need to be relocated after tenant improvements • OAT sensor reads high in sunlight
c.3 (10)	**Controls "hunt" / need Loop Tuning or separation of heating/cooling setpoints**
	• CHW valve cycles open and closed • System needs loop tuning – it is cycling between heating and cooling
c.4 (11)	**OTHER Controls**
	• Please contact PBEEEP Project Engineer for approval
d.1 (12)	**Daylighting controls or occupancy sensors need optimization**
	• Existing controls are not functioning or overridden • Light sensors improperly placed or out of calibration
d.2 (13)	**Zone setpoint setup / setback are not implemented or are sub-optimal**
	• The cooling setpoint is 74 ºF 24 hours per day
d.3 (14)	**Fan Speed Doesn't Vary Sufficiently**
	• Fan runs at 2" static pressure. Lowering pressure to 1.8" does not create comfort problem and the flow is per design. • Supply air temperature and pressure reset: cooling and heating

d.4 (15)	**Pump Speed Doesn't Vary Sufficiently**	
		• Pump runs at 15 PSI on peak day. Lowering pressure to 12 does not create comfort problem and the flow is per design. Low ΔT across the chiller during low load conditions.
d.5 (16)	**VAV Box Minimum Flow Setpoint is higher than necessary**	
		• Boxes universally set at 40%, regardless of occupancy. Most boxes can have setpoints lowered and still meet minimum airflow requirements.
d.6 (17)	**Other Controls (Setpoint Changes)**	
		• Please contact PBEEEP Project Engineer for approval
e.1 (18)	**HW Supply Temperature Reset is not implemented or is sub-optimal**	
		• HW supply temperature is a constant 180 ºF. It should be reset based on demand, or decreased by a reset schedule as OAT increases. • DHW Setpoints are constant 24 hours per day
e.2 (19)	**CHW Supply Temperature Reset is not implemented or is sub-optimal**	
		• CHW supply temperature is a constant 42 ºF. It could be reset, based on demand or ambient temperature.
e.3 (20)	**Supply Air Temperature Reset is not implemented or is sub-optimal**	
		• The SAT is constant at 55 ºF. It could be reset to minimize reheat and maximize economizer cooling. The reset should ideally be based on demand (e.g., looking at zone box damper positions), but could also be reset based on OAT.
e.4 ( )	**Supply Duct Static Pressure Reset is not implemented or is suboptimal**	
		• The Duct Static Pressure (DSP) is constant at 1.5" wc. It could be reset to minimize fan energy. The reset should ideally be based on demand (e.g. looking at zone box damper positions), but could also be reset based on OAT.
e.5 (21)	**Condenser Water Temperature Reset is not implemented or is sub-optimal**	
		• CW temperature is constant leaving the tower at 85 ºF. The temperature should be reduced to minimize the total energy use of the chiller and tower. It may be worthwhile to reset based on load and ambient conditions.
e.6 (22)	**Other Controls (Reset Schedules)**	
		• Please contact PBEEEP Project Engineer for approval
f.1 (23)	**Lighting system needs optimization - Spaces are overlit**	
		• Lighting exceeds ASHRAE or IES standard levels for specific space types or tasks
f.2 (24)	**Pump Discharge Throttled**	
		• The discharge valve for the CHW pump is 30% open. The valve should be opened and the impeller size reduced to provide the proper flow without throttling.
f.3 (25)	**Over-Pumping**	
		• Only one CHW pump runs when one chiller is running. However, due to the reduced pressure drop in the common piping, the pump is providing much greater flow than needed.
f.4 (26)	**Equipment is oversized for load**	
		• The equipment cycles unnecessarily • The peak load is much less than the installed equipment capacity

f.5 (27)	**OTHER Equipment Efficiency/Load Reduction**	
		• Please contact PBEEEP Project Engineer for approval
g.1 (28)	**VFD Retrofit Fans**	
		• Fan serves variable flow system, but does not have a VFD. • VFD is in override mode, and was found to be not modulating.
g.2 (29)	**VFD Retrofit - Pumps**	
		• 3-way valves are used to maintain constant flow during low load periods. • Only one CHW pumps runs when one chiller is running. However, due to the reduced pressure drop in the common piping, the pump is providing much greater flow than needed.
g.3 (30)	**VFD Retrofit - Motors (process)**	
		• Motor is constant speed and uses a variable pitch sheave to obtain speed control.
g.4 (31)	**OTHER VFD**	
		• Please contact PBEEEP Project Engineer for approval
h.1 (32)	**Retrofit - Motors**	
		• Efficiency of installed motor is much lower than efficiency of currently available motors
h.2 (33)	**Retrofit - Chillers**	
		• Efficiency of installed chiller is much lower than efficiency of currently available chillers
h.3 (34)	**Retrofit - Air Conditioners (Air Handling Units, Packaged Unitary Equipment)**	
		• Efficiency of installed air conditioner is much lower than efficiency of currently available air conditioners
h.4 (35)	**Retrofit - Boilers**	
		• Efficiency of installed boiler is much lower than efficiency of currently available boilers
h.5 (36)	**Retrofit - Packaged Gas-fired heating**	
		• Efficiency of installed heaters is much lower than efficiency of currently available heaters
h.6 (37)	**Retrofit - Heat Pumps**	
		• Efficiency of installed heat pump is much lower than efficiency of currently available heat pumps
h.7 (38)	**Retrofit - Equipment (custom)**	
		• Efficiency of installed equipment is much lower than efficiency of currently available equipment
h.8 (39)	**Retrofit - Pumping distribution method**	
		• Current pumping distribution system is inefficient, and could be optimized. • Pump distribution loop can be converted from primary to primary-secondary)
h.9 (40)	**Retrofit - Energy / Heat Recovery**	
		• Energy is not recouped from the exhaust air. • Identification of equipment with higher effectiveness than the current equipment.
h.10 (41)	**Retrofit - System (custom)**	
		• Efficiency of installed system is much lower than efficiency of another type of system
h.11 (42)	**Retrofit - Efficient lighting**	
		• Efficiency of installed lamps, ballasts or fixtures are much lower than efficiency of currently available lamps, ballasts or fixtures.

h.12 (43)	**Retrofit - Building Envelope**	
		• Insulation is missing or insufficient • Window glazing is inadequate • Too much air leakage into / out of the building • Mechanical systems operate during unoccupied periods in extreme weather
h.13 (44)	**Retrofit - Alternative Energy**	
		• Alternative energy strategies, such as passive/active solar, wind, ground sheltered construction or other alternative, can be incorporated into the building design
h.14 (45)	**OTHER Retrofit**	
		• Please contact PBEEEP Project Engineer for approval
i.1 (46)	**Differed Maintenance from Recommended/Standard**	
		• Differed maintenance that results in sub-optimal energy performance. • Examples: Scale buildup on heat exchanger, broken linkages to control actuator missing equipment components, etc.
i.2 (47)	**Impurity/Contamination**	
		• Impurities or contamination of operating fluids that result in sub-optimal performance. Examples include lack of chemical treatment to hot/cold water systems that result in elevated levels of TDS which affect energy efficiency.
i.3 ( )	**Leaky/Stuck Damper**	
		• The outside or return air damper on an AHU is leaking or is not modulating causing the energy use go up because of additional load to the central heating and/or cooling plant.
i.4 ( )	**Leaky/Stuck Valve**	
		• The heating or cooling coil valve on an AHU is leaking or is not modulating causing the energy use go up because of additional load to the central heating and/or cooling plant.
i.5 (48)	**OTHER Maintenance**	
		• Please contact PBEEEP Project Engineer for approval
j.1 (49)	**OTHER**	
		• Please contact PBEEEP Project Engineer for approval

Findings Summary

Building: Main Bldg A

Site: Lake Superior College

Eco #	Investigation Finding	Total Cost	Savings	Payback	Co-Funding	Payback Co-Funding	GHG
1	AHU Operation Schedules Need Optimization	$1,074	$8,576	0.13	$0	0.13	82
2	Economizign Operations	$2,114	$603	3.50	$0	3.50	10
	Total for Findings with Payback 3 years or less:	**$1,074**	**$8,576**	**0.13**	**$0**	**0.13**	**82**
	Total for all Findings:	**$3,188**	**$9,179**	**0.35**	**$0**	**0.35**	**92**

PBEEEP was made possible with funding from the U.S. Department of Energy
and the MN Department of Commerce.

Findings Details

Building: Main Bldg A

FWB Number:	15501	Eco Number:	1
Site:	Lake Superior College	Date/Time Created:	6/1/2012

Investigation Finding:	AHU Operation Schedules Need Optimization	Date Identified:	10/1/2011
Description of Finding:	AHU operation schedules are excessive. Energy is wasted when fans operate during unoccupied hours		
Equipment or System(s):	AHU with heating and cooling	Finding Category:	Equipment Scheduling and Enabling
Finding Type:	Equipment is enabled regardless of need, or such enabling is excessive		

Implementer:	Controls contractor	Benefits:	Adjusting the supply and return air fan operations to the current building schedule reduces exessive run times and electrical energy use. It also increased the fan life.
Baseline Documentation Method:	Trending of outside air damper position, supply and return air fan operation, return air, make-up air, zone temperatures and discharge air temperatures in AHUs were documented through the Building Automation System. The trended data for damper opening, supply and return air fan operation showed that outside air dampers opened and fans operated excessively during unoccupied hours.		
Measure:	Air Handling Units (AHU) operating schedules shall be tailored to the current schedule of the spaces each unit serves.		
Recommendation for Implementation:	The building automation controls should also be modified so that the supply and return air fan schedules for AHU-1 1856',AHU 4, SAHU-3, and VUAHU-4 correspond to their zone public occupancy schedule. When the unit's zone setpoint is met, supply and return air fans should turn off when the building closes to the public at night and remain off until one hours prior to the public opening in the morning. The fans should run during unoccupied hours only if their unit zone temperature setpoints are not met or during the one hour warm-up prior to public hours. The proposed AHU operation schedules are the following: AH-1856: Monday through Friday 6 AM to 10 PM, Off Saturday and Sunday AHU-4: Monday through Friday 6 AM to 10 PM, Off Saturday and Sunday SAHU-3: Monday through Friday 6 AM to 10 PM, 8 AM to 6 PM Saturday and Off Sunday VUAHU-4: Monday through Friday 6 AM to 10 PM, 8 AM to 6 PM Saturday and Off Sunday		
Evidence of Implementation Method:	The Building Automation System will collect trend data in 15 minute incrementson for the following points in all AHUs: OA damper %, SF VFD %, RF VFD %, Discharge Air Temperature, Return Air Temperature, Mixed Air Temperature, and Outside Air Temperature. The trending should verify that the unit suppy and return air fans turn off when the building close to the public at night. The trending should also verify that the supply and return air fans only operate during unoccupied times when the unit zone temperature setpoints are not met.		

Annual Electric Savings (kWh):	42,556	Annual Natural Gas Savings (therms):	8,248
Estimated Annual kWh Savings ($):	$2,258	Estimated Annual Natural Gas Savings ($):	$6,318
Contractor Cost ($):	$750		
PBEEEP Provider Cost for Implementation Assistance ($):	$324		
Total Estimated Implementation Cost ($):	$1,074		

Estimated Annual Total Savings ($):	$8,576	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	0.13	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	0.13	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	82	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	93.4%	Percent of Implementation Costs:	33.7%

Findings Details

Building: Main Bldg A

FWB Number:	15501	Eco Number:	2
Site:	Lake Superior College	Date/Time Created:	6/1/2012

Investigation Finding:	Economizign Operations	Date Identified:	10/1/2011
Description of Finding:	Trend data for AHU 4, 5, 6, and 7 show that the economizer high limits not maximized. This setpoint is significantly lower than the typical optimum setpoint for Minnesota of 71°F.		
Equipment or System(s):	AHU with heating and cooling	Finding Category:	Economizer/Outside Air Loads
Finding Type:	Economizer Operation - Inadequate Free Cooling (Damper failed in minimum or closed position, economizer setpoints not optimized)		

Implementer:	Controsl contractor or staff	Benefits:	Uses 'free cooling' when appropriate outside air properties exist instead of energy intensive mechanical cooling.
Baseline Documentation Method:	This finding was determined by looking at data from the BAS. The DAT, cooling valve, heating valve, damper, OAT, RAT, and MAT were used to help find the issue with the AHUs and RTUs		
Measure:	Change upper limit for economizing to 71F		
Recommendation for Implementation:	On AHU-4, AHU-5, AHU-6, and AHU-7 reset the upper limit for economizing to 71F. If zone temperatures can't meet setpoints, economizing will be disengaged and the cooling will engage and sequence the staging to assure the zone temperture is met. DAT will be adjusted during economizer.		
Evidence of Implementation Method:	Trends will be gathered on the MAT, OA Damper , Zone Temperature, SF Speed, RF Speed, DAT and OAT for 15 minute intervals when the OAT isbetween 55F and 76F to show the new economizer setpoints are working correctly. These trends will be gathered for a two week period to show it is working effectively.		

Annual Electric Savings (kWh):	11,372	Contractor Cost ($):	$1,250
Estimated Annual kWh Savings ($):	$603	PBEEEP Provider Cost for Implementation Assistance ($):	$864
		Total Estimated Implementation Cost ($):	$2,114

Estimated Annual Total Savings ($):	$603	Utility Co-Funding for kWh ($):	$0
Initial Simple Payback (years):	3.50	Utility Co-Funding for kW ($):	$0
Simple Payback w/ Utility Co-Funding (years):	3.50	Utility Co-Funding for therms ($):	$0
GHG Avoided in U.S. Tons (C02e):	10	Utility Co-Funding - Estimated Total ($):	$0

Current Project as Percentage of Total project			
Percent Savings (Costs basis)	6.6%	Percent of Implementation Costs:	66.3%

PBEEEP State Government

Rev. 2.0 (12/16/2010)

15501 - Lake Superior Main Campus

This checklist is designed to be a resource and reference for Providers and PBEEEP.

Finding Category	Finding Type Number	Finding Type	Relevant Findings (if any)	Finding Location	Reason for no relevant finding	Notes
a. Equipment Scheduling and Enabling:	a.1 (1)	Time of Day enabling is excessive	AHU	AHU		AHU and RTU schedules are excessive.
	a.2 (2)	Equipment is enabled regardless of need, or such enabling is excessive	SEE A1.1			
	a.3 (3)	Lighting is on more hours than necessary.	None		Investigation looked for, but did not find this issue.	Lighting followed building occupancy schedule.
	a.4 (4)	OTHER_Equipment Scheduling/Enabling	None		Investigation looked for, but did not find this issue.	No other Equipment scheduling/Enabling were found.
b. Economizer/Outside Air Loads:	b.1 (5)	Economizer Operation – Inadequate Free Cooling (Damper failed in minimum or closed position, economizer setpoints not optimized)	Measure 2	AHU		Economizer setpoints are not maximized.
	b.2 (6)	Over-Ventilation – Outside air damper failed in an open position. Minimum outside air fraction not set to design specifications or occupancy.	None		Investigation looked for, but did not find this issue.	
	b.3 (7)	OTHER_Economizer/OA Loads	None		Investigation looked for, but did not find this issue.	
c. Controls Problems:	c.1 (8)	Simultaneous Heating and Cooling is present and excessive	None		Investigation looked for, but did not find this issue.	No simultaneous heating & cooling was detected.
	c.2 (9)	Sensor/Thermostat needs calibration, relocation/shielding, and/or replacement	None		Investigation looked for, but did not find this issue.	
	c.3 (10)	Controls "hunt" and/or need Loop Tuning or separation of heating/cooling setpoints	None		Investigation looked for, but did not find this issue.	
	c.4 (11)	OTHER_Controls	None			
d. Controls (Setpoint Changes):	d.1 (12)	Daylighting controls or occupancy sensors need optimization.	None		Investigation looked for, but did not find this issue.	
	d.2 (13)	Zone setpoint setup/setback are not implemented or are sub-optimal.	None		Investigation looked for, but did not find this issue.	
	d.3 (14)	Fan Speed Doesn't Vary Sufficiently	None		Investigation looked for, but did not find this issue.	
	d.4 (15)	Pump Speed Doesn't Vary Sufficiently	None		Investigation looked for, but did not find this issue.	
	d.5 (16)	VAV Box Minimum Flow Setpoint is higher than necessary	None		Investigation looked for, but did not find this issue.	When zone temperture is met, VAV operate minimum setpionts
	d.6 (17)	Other_Controls (Setpoint Changes)	None			No other control issues found
e. Controls (Reset Schedules):	e.1 (18)	HW Supply Temperature Reset is not implemented or is sub-optimal	None		Investigation looked for, but did not find this issue.	Looking at trending data and plotting HWS VS OAT No issues were found with HW Reset. Also both boiler plants are being remodeled this summer. Controls will can on both heating plants
	e.2 (19)	CHW Supply Temperature Reset is not implemented or is sub-optimal	None		Investigation looked for, but did not find this issue.	
	e.3 (20)	Supply Air Temperature Reset is not implemented or is sub-optimal	None		Investigation looked for, but did not find this issue.	Looking at trending data and plotting DAT VS OAT No issues were found with SA Reset.
	e.4 ( )	Supply Duct Static Pressure Reset is not implemented or is sub-optimal	None			
	e.5 (21)	Condenser Water Temperature Reset is not implemented or is sub-optimal	None		Not cost-effective to investigate	
	e.6 (22)	Other_Controls (Reset Schedules)	None		Investigation looked for, but did not find this issue.	
f. Equipment Efficiency Improvements / Load Reduction:	f.1 (23)	Daylighting Control needs optimization—Spaces are Over-Lit	None		Investigation looked for, but did not find this issue.	
	f.2 (24)	Pump Discharge Throttled	None		Investigation looked for, but did not find this issue.	Did not notice any pump throttling
	f.3 (25)	Over-Pumping	None		Investigation looked for, but did not find this issue.	
	f.4 (26)	Equipment is oversized for load.	None		Investigation looked for, but did not find this issue.	
	f.5 (27)	OTHER_Equipment Efficiency/Load Reduction	None		Investigation looked for, but did not find this issue.	
	g.1 (28)	VFD Retrofit - Fans	None		Not cost-effective to investigate	All largre fans has vfds. Also a large number of small fans do as well

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15501 - Lake Superior Main Campus

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Finding Category	Finding Type Number	Finding Type	Relevant Findings (if any)	Finding Location	Reason for no relevant finding	Notes
g. Variable Frequency Drives (VFD):	g.2 (29)	VFD Retrofit - Pumps	None		Not cost-effective to investigate	large pumps already hav vfds
	g.3 (30)	VFD Retrofit - Motors (process)	None		Not Relevant	No Processes
	g.4 (31)	OTHER_VFD	None		Investigation looked for, but did not find this issue.	No issuesd found
h. Retrofits:	h.1 (32)	Retrofit - Motors	None		Not cost-effective to investigate	Payback would not be less than 15 years.
	h.2 (33)	Retrofit - Chillers	None		Not cost-effective to investigate	Payback would not be less than 15 years.
	h.3 (34)	Retrofit - Air Conditioners (Air Handling Units, Packaged Unitary Equipment)	None		Not cost-effective to investigate	Payback would not be less than 15 years.
	h.4 (35)	Retrofit - Boilers	None		Not cost-effective to investigate	Boiler system is being redesigned this spring
	h.5 (36)	Retrofit - Packaged Gas fired heating	Already gas fired.	Observation	Not Relevant	Gas is used throughout the facility
	h.6 (37)	Retrofit - Heat Pumps	None		Not cost-effective to investigate	Payback would not be less then 15 years
	h.7 (38)	Retrofit - Equipment (custom)	None		Investigation looked for, but did not find this issue.	No custom equipment
	h.8 (39)	Retrofit - Pumping distribution method	None		Investigation looked for, but did not find this issue.	Pumping distribution method is being redesigned this spring
	h.9 (40)	Retrofit - Energy/Heat Recovery	Some RTU/AHU's have Energy Recovery		Not cost-effective to investigate	Payback would not be less than 15 years
	h.10 (41)	Retrofit - System (custom)	None		Investigation looked for, but did not find this issue.	No custom equipment.
	h.11 (42)	Retrofit - Efficient Lighting	None			
	h.12 (43)	Retrofit - Building Envelope	Not in Scope		Not Relevant	Was not in scope of services.
	h.13 (44)	Retrofit - Alternative Energy	Not in Scope		Not Relevant	Was not in scope of services.
	h.14 (45)	OTHER_Retrofit	None		Investigation looked for, but did not find this issue.	None without looking into large capital projects.
i. Maintenance Related Problems:	i.1 (46)	Differed Maintenance from Recommended/Standard	None found.		Investigation looked for, but did not find this issue.	No problems found.
	i.2 (47)	Impurity/Contamination	None.		Investigation looked for, but did not find this issue.	None found.
	i.3 ( )	Leaky/Stuck Damper	None		Investigation looked for, but did not find this issue.	No problems found.
	i.4 ( )	Leaky/Stuck Valve	None		Investigation looked for, but did not find this issue.	None found.
	i.5 (48)	OTHER_Maintenance	None		Investigation looked for, but did not find this issue.	No comment
j. OTHER	j.1 (49)	OTHER	None		Investigation looked for, but did not find this issue.	No comment

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April 29, 2012

ATTACHMENT A: LAKE SUPERIOR COLLEGE

RECOMMENDED MEASURES

Measure #1. Optimization of Air Handler Operation Schedules.
The building automation controls should also be modified so that the supply and return air handling unit fan schedules for AHU-1 1856', 4, SAHU-3, VUAHU-4, and VUAHU-6 correspond to their zone public occupancy schedule. When the unit's zone setpoint is met, supply and return air fans should turn off when the building closes to the public at night and remain off until one hours prior to the public opening in the morning. The fans should run during unoccupied hours only if their unit zone temperature setpoints are not met or during the one hour warm-up prior to public hours. The proposed AHU operation schedules are 6AM-10PM M-F. The proposed measure will save motor energy along with heating (natural gas) and cooling (electrical) energy.

Measure #2. Economizer operation.
Economizer operations for Air Handling Units AHU-1 1856', Art AHU, AHU-4, 5, 6, 7, SAHU-3, VUAHU-1, 2 and VUAHU-4 are presently lower than what is recommended for Minnesota climat. Reset the upper limit for economizing to 71F. If zone temperatures can't meet setpoints, economizing will be disengaged and the cooling will engage and sequence the staging to assure the zone temperture is met. DAT will be adjusted during economizer. The proposed measure with save cooling (electrical) energy.

ADDITIONAL FINDINGS AND BEST PRACTICE RECOMMENDATIONS

1. Verify operation of airflow measuring station serving Air Handling Unit AHU-1-90.

2. Verify Air Handling Units AHU-1-90 and AHU-3-90, heating control valves are closing fully.

3. Verify outside air damper serving Air Handling Unit AHU-14 is sealing.

4. Verify Air Handling Unit VUAHU-9 is not simultaneously heating and cooling.

5. Verify if Air Handling Unit VUAHU-1 cooling valve closes in economizer.

6. Air Handling Units have heating coils and control valves. The control valves are opened to 100% during the buildings unoccupied time. This is done to deter the coils from freezing during wintertime extremes, if the outside air dampers do not close properly. The building heating water system **does not** have Glycol running through the system to deter coil freeze up. The coil control valves could be closed or controlled to be partially open during unoccupied periods, which should save pumping power and heat transfer into the air handling units.

7. Recommend calibrating CO2 sensors, outside air flow measuring stations, temperature and humidity sensor on a regular maintenance schedule. For larger occupancy areas, CO2, VFD's and AFMS could be used to monitor and reduce outside airflow, while still meeting indoor air quality and comfort levels. Also, CO2 sensors do not appear to be controlling anything, and could be tied into OSA damper to adjust/reduce damper position after CO2 sensor calibration.

Additional items for energy savings:

1. The Art building boiler system is designed, bid and a contractor will be given approval to being construction in mid-May. The existing boiler is steam is being replaced with two natural gas fired condensing high efficiency hot water boilers. An estimate has been provided to the gas utility for annual natural gas savings of $1200.00. Awaiting rebate information from the utility.

2. The main building boiler plant is being refurbished and converted to a hybrid boiler system. One of the three existing standard efficiency boiler is being replaced with two natural gas fired condensing high efficiency hot water boilers. The present domestic water heating system is heated of the main boilers. This is being replaced with a high efficiency water heaters. This project presently does not have funding to proceed.

3. UVAHU-8, 10 and 11 are scheduled to be replaced when the owner acquires funding for the projects.

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PBEEEP
State Government

Public Buildings Enhanced Energy Efficiency Program

SCREENING RESULTS FOR
LAKE SUPERIOR COLLEGE

Lake Superior College

May 2, 2011

Summary Table

Lake Superior College	
Location	2101 Trinity Road, Duluth MN 55811
Facility Manager	Gary Adams
Number of Buildings	15
Interior Square Footage	362,775
PBEEEP Provider	Center for Energy and Environment (Neal Ray)
Date Visited	March 29, 2011
Annual Energy Cost (from B3)	$493,214.71
Utility Company	4,433, 960 kWh (2010) Minnesota Power (Electric), 178,795 Therms (2010) Comfort Systems (Natural Gas)
Site Energy Use Index (from B3)	95 kBtu/sq ft(2010)
Benchmark EUI (from B3)	126 kBtu/sq ft

Screening Overview

The goal of screening is to select buildings where an in-depth energy investigation can be performed to identify energy savings opportunities that will generate savings with a relatively short (1 to 5 years) and certain payback. The screening of Lake Superior College was performed by the Center for Energy and Environment (CEE) with the assistance of the facility staff. A walk-through was conducted on March 29, 2011 and interviews with the facility staff were carried out to fully explore the status of the energy consuming equipment and their potential for recommissioning. This report is the result of that information.

Lake Superior College campus consists of 362,775 square feet (sqft) and is compromised of 15 different buildings located in Duluth, MN. There are two locations in Duluth; one area consists of 328,605 sqft which consists of the main campus buildings (5 attached buildings) and four other detached buildings.

There is also a new Health and Science Center building which is currently being constructed at the main campus location which was not complete when the screening took place.

The other portion of the campus at a different location is the Emergency Response Training Center (ERTC). This portion of the campus consists of 34,170 sqft and a total of six different buildings.

Recommendation for Investigation

An investigation of the energy usage and energy savings of six selected buildings is recommended for Lake Superior College. The main campus buildings, which form one attached building; a group made up of five different building sections which were constructed between 1966 and 2007 totaling 309,805 sqft, is recommended for an investigation. The detached Art building on the main campus location consisting of 11,600 sqft is also recommended for an investigation. Three small detached buildings; Auto Storage, Cold Storage, and Worm Building are not recommended for investigation. The new Health and Science Center which is still being constructed is not recommended as well.

The ERTC is not recommended for an investigation

Buildings Recommended for Investigation

Building Name	State ID	Square Footage	Year Built
1986 Addition	E26354T0486	42,865	1986
1990 Addition	E26354T0590	31,680	1990
96 Addition	E26354T1196	69,900	1996
Academic & Student Services	E26354T1207	45,735	2007
Art Building	E26354T0775	11,600	1975
Main Bldg A	E26354T0166	119,625	1966

Buildings Not Recommended for Investigation

Building Name	State ID	Square Footage	Year Built
Auto Storage	E26354T0690	1,200	1990
Cold Storage	E26354T0382	5,400	1982
Worm Building	E26354T0995	600	2000
ERTC Generator Bldg	E26354T0894	821	1994
ERTC Outdoor Classroom		650	1994
ERTC Treat/Equip Bldg.		510	1994
ERTC Treatment Tank		1,808	1994
Fire/Rescue Classroom	E26354T0994	27,534	1994
Fire/Rescue Tower	E26354T1094	2,847	1994

Building Overview Section

Mechanical Equipment

The building group contains 3 boilers which produce hot water for heating: 2 large boilers and one small boiler. There are four hot water loops for distribution. There are a total of 8 hot water pumps distributing hot water from the boilers. The Art building also contains a small boiler which produces steam.

There are a total of four chillers on the campus; two of them are located on the roof of the complex and two smaller chillers called the West End Chiller and East End Chiller which produce chilled water for the campus. The art building is cooled by a DX condensing unit

The main campus building contains a total of 24 AHUs, these units were installed between 1966 and 2007. They are all on the automation system. There are a total of approximately 170 VAV boxes associated with these AHUs, most of the VAVs contain reheats. There are 17 fan powered VAVs also.

The Art building has one AHU which serves the building. It is a constant volume unit with a steam coil for heat. The unit is old and staff states it is a very problematic unit.

The following table lists the key mechanical equipment for the buildings recommended for investigation at the facility.

Mechanical Equipment Summary Table	
Quantity	**Equipment Description**
1	Johnson Metasys Automation System
6	Building
321,405	Interior Square Feet (before 1,200 sqft addition)
25	Air Handlers
170	VAV Boxes (Estimate, 17 fan powered)
4	Boilers
4	Air cooled chillers
8	Hot water pumps
10	Chilled water pumps (estimated)
2725	Approximate number of points on the BAS
750	Approximate number of points required for trending by PBEEEP Guidleines
20	Data Loggers for Cooling System (does not include loggers for lighting or occupancy sensors)

Controls and Trending

The building runs on a Johnson Metasys Building Automation System (BAS). The system contains the Application and Data Server (ADS) package which allows trends to be set up and stored on a Sequel Server (SQL). The system did not appear to have the software Export Utility, which can be used to extract the trends from the SQL server. Trends can be extracted directly from the SQL server file, but would require manipulation of data by the provider to get the trends in csv format.

There are approximately 10 chilled water pumps which are not automated and would require data logging to understand their operation.

Lighting

Indoor lighting- Interior lighting consists of mainly T8 32 watt which are controlled by switches.

Outdoor lighting- The outdoor lighting consists of high pressure sodium (HPS) lights. The lights are on timers and controlled on the automation system.

Energy Use Index B3 Benchmark

The site Energy Use Index (EUI) for the building is 95 kBtu/sqft, which is 25% lower than the B3 Benchmark of 126 kBtu/sqft. The site EUIs for State of Minnesota buildings are 23% lower than their corresponding B3 Benchmarks on average.

Metering

The campus contains a total of nine electrical meters. Three of the meters are associated with the ERTC complex and another one is associated with the cold storage. There are a total of four gas meters and two of them are associated with the ERTC building.

Documentation

The complex has a large amount of documentation. It is fairly complete but a bit disorganized; however there are electronic copies of many of the prints for projects which were done at the campus which helps in finding information on building on equipment within the complex.

Additional Information form Occupants Interviews and Observations

The following information **has not been verified** and was obtained through occupant interviews and/or general observations by the PBEEEP Screening team. This information is provided for reference only:

- There are possible future projects to replace some of the Ventilation units (VUAHU in the screening report) in the near future
- The recent project upgrade for the East End Cooling was commissioned.
- There testing and balance reports are available for many of the recent projects.
- During an investigation most focus should be spent on the control of the mechanical equipment and trending the automation system.

Reasons for Recommendation

This screening report is based on the PBEEEP Guidelines. It is based on one site visit, review of the facility documentation, building automation system, a limited inspection of the facility and interviews with the staff. The purpose of the screening report is to evaluate the potential of the facility for the implementation of cost-effective energy efficiency savings through recommissioning. To the best of our knowledge the information here is accurate. It provides a high level view of many of the important parameters of the mechanical equipment in the facility. Because it is the result of a limited audit survey of the facility, it may not be completely accurate or inclusive.

There are many factors that are part of the decision to recommend an energy investigation of a building. Some characteristics at Lake Superior College that were taken into account during the building selection process were:

- Potential energy savings opportunities observed during screening phase
- Large square footage
- Level of control by the building automation system
- Equipment size and quantity

Lake Superior College (Only Buildings Recommended for Investigation)					
Area (sqft)	321,405	Year Built	1966-2000	EUI/Benchmark	93/126
HVAC Equipment					

Ventilating Units (Total)

Description	**Type**	**Size**	**Notes**
VUAHU-1	Variable air volume with SF and RF		Installed in 2007
VUAHU-2	Variable air volume with SF and RF		Installed in 2007
VUAHU-4		2 SF @ 3HP	Graphics only show one supply fan however nameplate information on the unit state it has 2 supply fans. Installed in 2007
VUAHU-5			Installed in 2007
VUAHU-6	Constant volume	15,500 CFM 5 HP SF	
VUAHU-7	Constant volume	11,720 5 HP SF	
VUAHU-8		5 HP SF	Installed in 2007
VUAHU-9		5 HP SF	Installed in 2007
VUAHU-10	Constant volume	5,000 CFM 2 HP SF	
VUAHU-11	Constant volume	5,000 CFM 2 HP SF	
VUAHU-12		11,470 CFM 15 HP SF	
VUAHU-13	Variable air volume	Unknown design information	Installed in 2007 Contains 17 VAV boxes

HVAC Equipment Cont'd

Air Handling Units (Cont'd)

Description	Type	Size	Notes
AHU-1	Variable air volume	22,400 CFM 25 HP SF 15 HP RF	Installed in 2006. Has 41 VAV s associated with it
AHU-2	Variable air volume	11,710 CFM 15 HP SF 10 HP RF	Installed in 2006. Contains an ERU heat exchanger. Has 17 VAV s associated with it.
SAAHU-3	Constant volume		Installed in 1990, contains 10 VAV boxes
AHU-1 (Lower 90 Addition)	Variable air volume		
AH1-1856 (Lower 90 Addition)	Variable air volume		Contains 5 VAV boxes
AHU-4	Variable air volume	11,620 CFM 15 HP SF	Installed in 1996
AHU-5	Variable air volume	14,030 CFM 15 HP SF 7.5 HP RF	Installed in 1996
AHU-6	Variable air volume	14,270 CFM 15 HP SF 7.5 HP RF	Installed in 1996
AHU-7	Variable air volume	10,215 CFM 15 HP SF 7.5 HP RF	Installed in 1996
AHU-13	Variable air volume	17,345 CFM 20 HP SF	Contains a TAB report installed in 2008
AHU-14	Variable air volume	20,080 CFM 25 HP SF 15 HP RF	Contains TAB report installed in 2008
AHU-15	Variable air volume	18,500 CFM 25 HP SF 10 HP RF	Contains TAB report installed in 2008
Art AHU	Constant volume	Unknown design conditions	

VAV boxes (Estimated 150 total)

Description	Type	Size	Notes
VAV	Reheat and no reheat		

Fan PoweredVAV boxes (17 Total)

Description	Type	Size	Notes
FPVAV-1 through 17	Fan powered		Associated with AHU-1 and AHU-2

HVAC Equipment Cont'd

Ceiling Air Units

Description	Type	Size	Notes
Room W3602	Constant volume	Unknown design conditions	Installed in 1990
Room W3616	Constant volume	Unknown design conditions	Installed in 1990
Room W3624	Constant volume	Unknown design conditions	Installed in 1990
Room W3674	Constant volume	Unknown design conditions	Installed in 1990

Chilled Water System

Description	Type	Size	Notes
2 Main Chillers	Air cooled	180 tons each	
West End chiller	Air cooled	55 tons	
East end chiller	Air cooled	65 tons	

HVAC Equipment Cont'd

Hot Water System Main Building

Description	**Type**	**Size**	**Notes**
2 Main HW Boilers	Hot water	Each rated at 8375 kBtu/hr	
1 Smaller Boiler	Hot water	3350 kBtu/hr	
2 Primary HWP	Primary HWPs	5 HP 650 gpm	
2 HWPs	Constant volume secondary pumps	15 HP 710 gpm	From original 1968 construction
2 HWPs	Variable volume secondary pumps	5 HP 225 gpm	Installed with the 1990 addition
2 HWPs	Variable volume secondary pumps	10 HP 100 gpm	Installed with the 1996 addition
2 HWPs	Variable volume secondary pumps	3 HP 80 gpm	Installed with the student services
Art Room Boiler	Steam boiler	940 kBtu/hr input	Associated with the Art AHU located in the Art Building

Points on BAS

Air Handlers

Description	Points
VUAHU-1 VUAHU-2	OA damper, Outside air CFM, MAT, HW valve%, CHW valve%, SF stat, SF speed, DAT, Zone temperature, RAT, RARH, MAT setpoint, RF status, RF speed, DAT setpoint, Supply static pressure setpoint, supply static pressure, Heat pump status
VUAHU-4	OA damper %, MAT, HW valve %, CHW valve %, SF stat, SF speed, DAT, Zone temperature, Zone temperature setpoint, RA CO_2, RARH, RAT, MAT setpoint, OAT economizer setpoint, Heating pump status, Kitchen hood status,
VUAHU-5	HW valve %, Face bypass damper%, SF speed, DAT, Zone reheat valve %, EF-stat, DAT setpoint, Night heating setpoint, Night cooling setpoint
VUAHU-6 VUAHU-7 VUAHU-10 VUAHU-11	OA damper %, MAT, HW valve %, SF status, DAT, Room temperature, RA CO_2, Damper min position setpoint, Night heating setpoint, night cooling setpoint, OAT economizer switch setpoint, Heating setpoint, Cooling setpoint, Indoor air quality calculated reset setpoint
VUAHU-8 VUAHU-9	OA damper %, MAT, HW valve %, Glcyol HX valve, DAT, SF status, Reheat valve %, Zone DAT, Zone temperature, Zone temperature setpoint, RAT, RARH, Exhaust damper %, HW pump enable setpoint, Night heating setpoint, Night cooling setpoint, Damper minimum position setpoint, DAT setpoint, OAT economizer switch setpoint
VUAHU-13	Occupancy command, Warm-up command, OAT, OAH, RAT, RARH, MAT, DAT, Zone temperature, Supply air static pressure, Outdoor air flow, SF command, SF status, SF speed, AHU CHWP status, HW valve %, OA damper %, DAT setpoint, OA heating enable setpoint, OA cooling enable setpoint, OA damper minimum position, Night heating setpoint, Night cooling setpoint, Duct static pressure setpoint
AHU-13 (86 Addition)	OA damper %, MAT, HW valve %, Cooling pump command, CHW valve %, SF status, SF speed, DAT, Zone temperature, RARH, RAT, Exhaust damper %, Minimum OA damper %, OAT Economizer setpoint, Supply air static pressure, DAT setpoint
AHU-14 (86 Addition) AHU-15 (86 Addition)	OA damper %, MAT, HW valve %, CHW valve %, SF status, SF speed, DAT, Zone temperature, RARH, RAT, RA CO_2 Exhaust damper %, Minimum OA damper %, OAT Economizer setpoint, Supply air static pressure, DAT setpoint, EF status, RF status, RF speed
AH1-1856 (90 Addition)	OA damper %, MAT, HW valve %, DX command %, SF status, SF speed, DAT, Room temperature, Night heating setpoint, Night cooling setpoint, OAT economizer switch setpoint, Damper min position setpoint, Cooling lockout setpoint, Supply duct static pressure, Supply static pressure setpoint, DAT setpoint
AHU-1 (90 Addition)	OA damper %, MAT, HW valve %, DX cooling stage 1 and 2, SF status, SF speed, DAT, Room temperature, RAT, RF status, RF speed, Night cooling setpoint, Night heating setpoint, OAT economizer switch setpoint, DAT setpoint, OA damper minimum position setpoint, Supply duct static pressure, Supply duct static pressure setpoint, Return duct static pressure, Return duct static setpoint

Points on BAS Cont'd

Air Handlers

Description	**Points**
SAHU-3 (90 Addition)	OA damper %, MAT, HW valve %, CHW valve %, SF status, DAT, Room temperature, EF status, RAT, EF damper %, Night cooling setpoint, Night heating setpoint, OA damper minimum positon setpoint, OAT economizer switch setpoint, DAT setpoint, Supply duct static pressure, Supply duct static pressure setpoint
AHU-4 AHU-5 AHU-6 AHU-7 (96 Addition)	OA damper %, MAT, HW valve %, CHW valve %, SF status, SF speed, DAT, Room temperature, RF status, RF speed, RA CO_2, EF damper %, Supply duct static pressure, Supply static pressure setpoint, Return duct static pressure, Return duct static pressure setpoint, IAQ calculated setpoint, DAT setpoint, OA damper minimum position setpoint, EF status setpoint
AHU-1	OAT, MAT, MAT setpoint, DAT, DAT setpoint, Heating coil DAT, Duct static pressure, Duct static pressure setpoint, OA CFM, Supply CFM, Return CFM, SF status, SF speed, RF status, RF speed, OA damper %, HW valve %, VHW valve %, Economizer status
AHU-2	Heat Recovery temperature, Heat coil DAT, Heat recovery setpoint, DAT, Duct static pressure, Duct static pressure setpoint, OA CFM, Return CFM Supply CFM, Zone temperature, Zone temperature setpoint, SF status, SF speed, RF status, RF speed, Heat recovery signal, HW valve %, CHW valve %, OA damper %, Face bypass damper %, Exhaust damper, Night heating setpoint, Night cooling setpoint
Art AHU	OA damper %, MAT, HW valve %, DX command %, SF status, DAT, Zone temperature, RA CO_2, EF damper %, OA damper minimum position setpoint, Cooling lockout setpoint, Face/Bypass compare setpoint, IAQ calculated reset setpoint, Calculated DAT heating setpoint, Night heating setpoint, Night cooling setpoint, OAT economizer switch setpoint

CHW system

Description	**Points**
Main Chiller campus	Compressor suction line temperature, Evaporator refrigerant pressure, OAT, Chiller capacity, CHWST setpoint, Evaporator pump run hours, Compressor starts, Condenser refrigerant pressure, Unit status
Main Chiller CHWPs	OAT, Cooling lockout setpoint, Chiller enable to run, Chiller load percent, VFD bypass, Cooling pump 1 command, Cooling pump 1 speed, VFD kWh, VFD Hertz output, VFD output %,
West End Chiller	West chiller alarm, West chiller command,
East End Chiller	OAT, Chiller setpoint, Chiller OA enable setpoint, Chiller run command, Chiller status, CHWST, CHWRT
Cooling	CHWP-1 status, CHWP speed, CHWST, CHWRT, Chiller Differential pressure, Chiller differential pressure setpoint, CHWP-2 command, CHW differential pressure, CHW differential pressure setpoint, Pump-1 status, Pump-2 status, Pump-3 status, Pump-4 status, Pump-5 status

Points on BAS Cont'd

HW system

Description	Points
Boiler room 1990 Addition	Pump-1 command, Pump-1 Amps, Pump-2 command, Pump-2 Amps
Boiler room 1996 Addition	Pump-4 command, Pump-4 speed, Pump-5 command, Pump-5 speed, HWS pressures
Boiler room 1986 Addition	HWP-1 command, HWP-1 speed, HWP-2 command, HWP-2 speed, HWST, HW differential pressure, HW differential pressure setpoint
Boiler room 1968 Addition	Pump-1 status, Pump-2 status
Boiler room 2006 Addition	Pump-1 status, Pump-2 status, Pump differential pressure, Pump differential pressure setpoint, Pump speed
Domestic HW	Occupied command, Domestic HW setpoint, Unoccupied domestic hot water setpoint, Domestic Water pump override, Domestic hot water supply temperature, Domestic HW pump command
Boiler Controls	Boiler HWST, Boiler HWRT, Boiler command

Ceiling Air Units

Description	Points
Room 3602 Room 3616 Room 3624 Room 3674	OA damper %, MAT, SF status, DX command %, HW valve %, Room temperature, Cooling lockout setpoint, Night heating setpoint, Night cooling setpoint, OA damper minimum position setpoint, Cooling space setpoint, Heating space setpoint, OAT economizer switch setpoint

VAV

Description	Points
VAV Boxes	CFM, CFM setpoint, Damper %, Reheat valve %, DAT, Radiant heating output, Zone temperature, Occupancy schedule, Effective heating setpoint, Effective cooling setpoint, Unoccupied heating setpoint, Unoccupied cooling setpoint

FPVAV

Description	Points
FPVAV Box	Occupancy status, Box mode, Fan command, Fan status, Zone temperature, Damper position, CFM, CFM setpoint

Points on BAS Cont’d

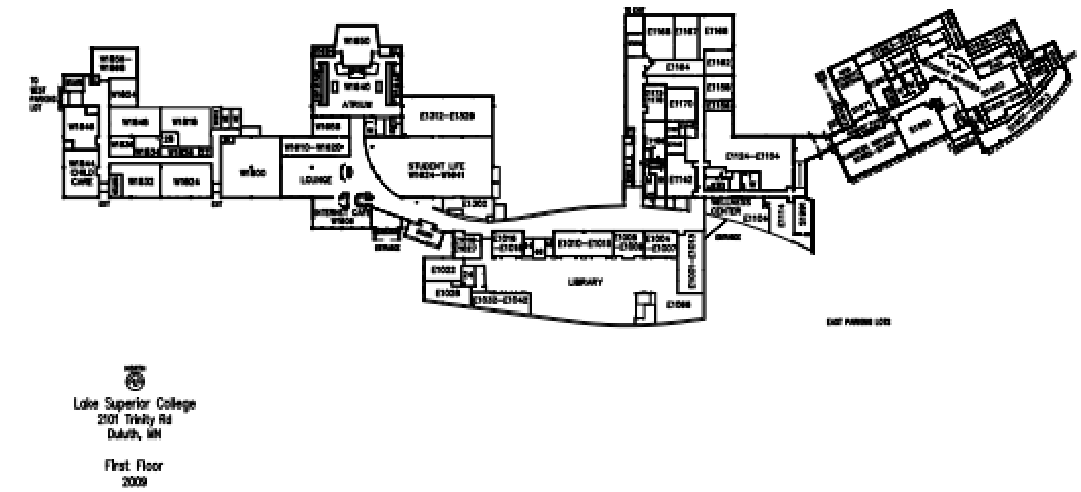
Lighting system

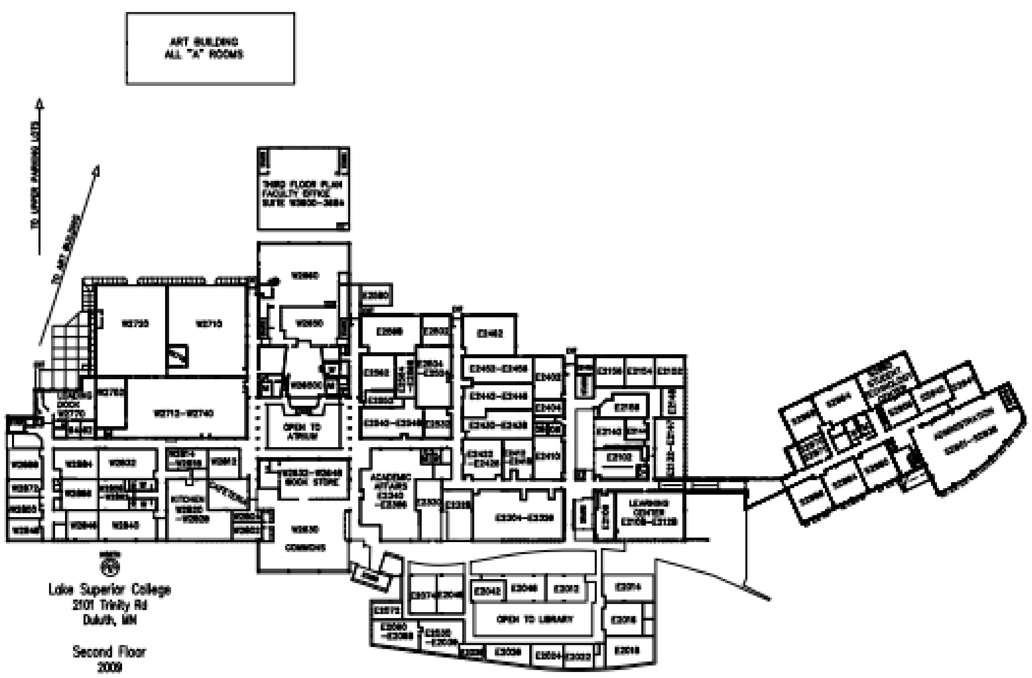
Description	Points
Lights	Parking lot schedule, Sidewall Light schedule, Corridor light schedule

Snow melt

Description	Points
Snow melt	Snowmelt enable, OAT, OAT enable setpoint

Map of the Facility





PBEEEP Abbreviation Descriptions			
AHU	Air Handling Unit	hp	Horsepower
BAS	Building Automation System	HRU	Heat Recovery Unit
CD	Cold Deck	HW	Hot Water
CDW	Condenser Water	HWDP	Hot Water Differential Pressure
CDWRT	Condenser Water Return Temperature	HWP	Hot Water Pump
CDWST	Condenser Water Supply Temperature	HWRT	Hot Water Return Temperature
cfm	Cubic Feet per Minute	HWST	Hot Water Supply Temperature
CHW	Chilled Water	HX	Heat Exchanger
CHWRT	Chilled Water Return Temperature	kW	Kilowatt
CHWDP	Chilled Water Differential Pressure	kWh	Kilowatt-hour
CHWP	Chilled Water Pump	MA	Mixed Air
CHWST	Chilled Water Supply Temperature	MA Enth	Mixed Air Enthalpy
CRAC	Computer Room Air Conditioner	MARH	Mixed Air Relative Humidity
CV	Constant Volume	MAT	Mixed Air Temperature
DA	Discharge Air	MAU	Make-up Air Unit
DA Enth	Discharge Air Enthalpy	OA	Outside Air
DARH	Discharge Air Relative Humidity	OA Enth	Outside Air Enthalpy
DAT	Discharge Air Temperature	OARH	Outside Air Relative Humidity
DDC	Direct Digital Control	OAT	Outside Air Temperature
DP	Differential Pressure	Occ	Occupied
DSP	Duct Static Pressure	PTAC	Packaged Terminal Air Conditioner
DX	Direct Expansion	RA	Return Air
EA	Exhaust Air	RA Enth	Return Air Enthalpy
EAT	Exhaust Air Temperature	RARH	Return Air Relative Humidity
Econ	Economizer	RAT	Return Air Temperature
EF	Exhaust Fan	RF	Return Fan
Enth	Enthalpy	RH	Relative Humidity
ERU	Energy Recovery Unit	RTU	Rooftop Unit
FCU	Fan Coil Unit	SF	Supply Fan
FPVAV	Fan Powered VAV	Unocc	Unoccupied
FTR	Fin Tube Radiation	VAV	Variable Air Volume
GPM	Gallons per Minute	VFD	Variable Frequency Drive
HD	Hot Deck	VIGV	Variable Inlet Guide Vanes

Conversions
1 kWh = 3.412 kBtu
1 Therm = 100 kBtu
1 kBtu/hr = 1 MBH